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Microstructure and piezoelectric response of AlN/SiC heterostructures grown on silicon substrates of different orientation

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Thin aluminum nitride (AlN) films are promissing materials as for optoelectronics and microelectromechanics [1-2]. Of special interest are AlN epitaxial films that can be grown on silicon substrates (Si) with a thin buffer layer of silicon carbide (SiC). Due to a small mismatch between the lattice parameters of AlN and SiC (on the order of 1%), epitaxial AlN films were successfully grown on these substrates by molecular beam epitaxy and chloride-hydride epitaxy (CHE) [3].

In the work, we studied the topography of the surface and the piezoelectric response of AlN/SiC heterostructures grown on Si substrates of different orientations - (100), (110) and (111). For these purposes, an atomic force microscope AFM-PFM Ntegra (NT-MDT) was used. Buffer layers of SiC 50-80 nm thick were formed by atoms substitution method [4]. To grow thin layers of AlN (thickness from fractions to several microns), the CHE method was used. The experiments revealed a strong difference in the growth pattern of the films. In particular, the normal growth of the hexagonal (polar) axis on the SiC/Si(111) substrate was replaced by a growth texture oriented at an angle of 50-53 degrees to the SiC/Si(100) substrate plane. Accordingly, the block size and the surface morphology were substantially changed (Fig. 1), as well as the magnitude of the piezoelectric response. The obtained results are discussed.

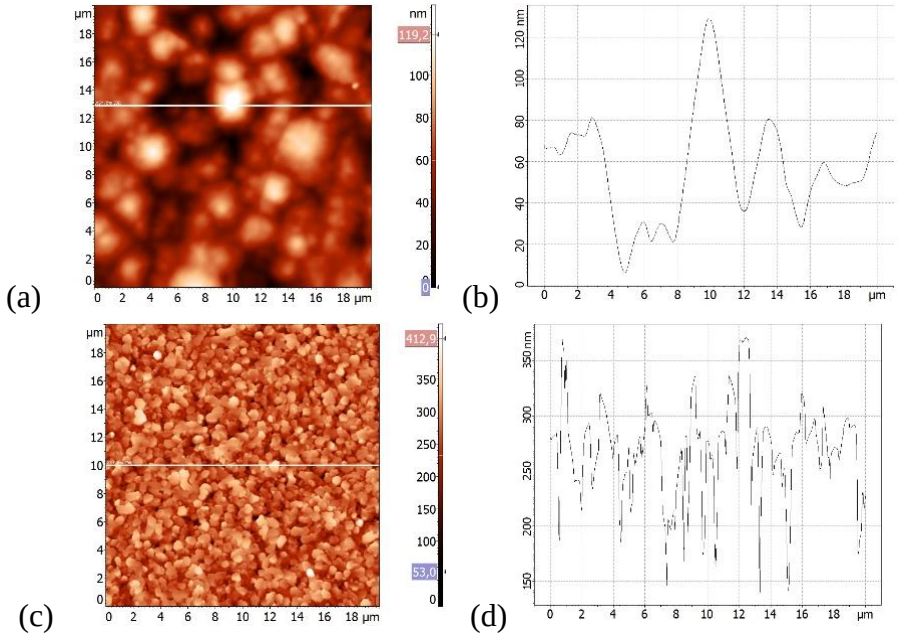

Figure 1. AFM images of thin AlN layers grown on (a, b) SiC/Si (111) and (c, d) SiC/Si (100) substrates.

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